The dimensions of the iron rings and their boxwood jackets were as follows :—

	Ring I.	Ring II.
Rings—		
External diameter......	6·9 cm.	6·1 cm.
Width................	2·9 ,,	3·0 ,,
Thickness	0·4 ,,	0·35 ,,
Mean radius	3·25 ,,	2·82 ,,
Boxwood jackets—		
External diameter......	7·7 ,,	6·9 ,,
Width................	3·7 ,,	3·8 ,,
Thickness............	1·3 ,,	1·15 ,,
Convolutions	515	473
Gauge of wire	0·91 mm.	0·91 mm.

The rings were formed from rectangular bars with welded joints, and were turned in the lathe to the above dimensions.

The magnetic fields were calculated from the formula $H = 2ni/r$ where n is the number of convolutions, i the C.G.S. current, and r the mean radius.

The current was derived from a battery of twenty-seven storage cells used for lighting the house.

IX. "On Correlation of certain External Parts of *Palæmon serratus*." By H. THOMPSON. Communicated by Professor WELDON, F.R.S. Received January 25, 1894.

In 1890 Professor Weldon published ('Roy. Soc. Proc.,' vol. 47, p. 445) the results of measurements of certain organs of the common shrimp, with a view to establish by accurate data the degree of variation existing in those organs. In a later paper ('Roy. Soc. Proc.,' vol. 51, p. 2) he determined, by Mr. Galton's method there described, the degree of correlation existing between four organs of the same animal, and in a recent paper ('Roy. Soc. Proc.,' vol. 54, p. 318) similar determinations have been worked out by him for certain organs of *Carcinus mœnas.*

Some time ago it was suggested to me by Professor Weldon that I should determine the values of correlated variations in a number of parts of the hard exoskeleton of the common prawn (*Palæmon serratus*). Accordingly, 1000 adult female prawns, chosen at random, were procured from Plymouth and measured. Twenty-two measurements were made of each prawn, except in the case of two or three measurements which were made on part only of the sample.

The parts measured were the following :—

I. Length of body from tip of rostrum to end of telson (excluding terminal spines).
II. From hindermost point of orbit to hinder edge of carapace in a straight line.
III. From tip of rostrum to median point of hinder edge of carapace.
IV. From tip of rostrum to tip of first dorsal spine.
V. From tip of rostrum to tip of last (hindermost) dorsal spine.
VI. From tip of first to tip of last dorsal spine.
VII. From tip of last dorsal spine to tip of the last but one.
VIII. From tip of last dorsal spine to median point of hinder edge of carapace (post-spinous portion of carapace).
IX*a*. The right squame from tip of tooth to posterior edge of the external articular tubercle.
IX*b*. The left squame measured in like manner.
X. The anterior and posterior median points of the 1st abdominal tergum.
XI. Posterior portion of the 1st abdominal tergum measured in like manner.
XII. The 2nd abdominal tergum measured in like manner.
XIII. The 3rd " " " "
XIV. The 4th " " " "
XV. The 5th " " " "
XVI. The 6th " " " "
XVII. The telson from the median point of the anterior edge to the tip of the median posterior projecting tooth (*i.e.*, excluding the terminal spines).
XVIII*a*. Exopodite of the 6th abdominal right appendage from the tip of the dorsal or fixed tooth to the posterior edge of the dorsal articular tubercle.
XVIII*b*. Exopodite of the 6th abdominal left appendage measured in like manner.
XIX*a*. From base of lateral spine projecting from the posterior end of the telson to the base of the posterior spine on the dorsal surface of the telson on the right side.
XIX*b*. Similar measurement for the left side.

Measurements I to III were made with compasses, and may be regarded as accurate to within about 0·5 mm., except No. I, the body length, which is somewhat less accurate. The remaining measurements were made under a microscope, and are accurate to within 0·05 mm.

For the purpose of comparison the measurements are all expressed in terms of the body length, which is taken as = 1000.

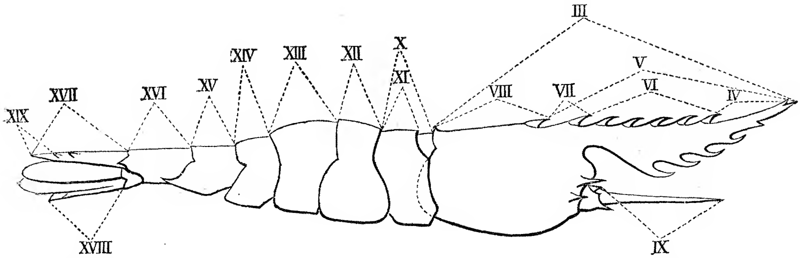

Diagram of exoskeleton of *Palæmon serratus* with appendages removed. The numerals refer to the numbers of the measurements.

Out of the 1000 prawns seven had a deformed rostrum, and six had a deformed telson. In several of the numerical results set out below these thirteen animals have been excluded because their deformities affected the body length to such an extent as to give a wholly fictitious value to the reduced measurements of the other organs.

The existence of a long rostrum in the prawn has proved a serious hindrance, since its length in proportion to that of the body is very variable, and hence those parts in which the rostrum is an element present a degree of correlation which is very slight, and render impossible any real comparison with the corresponding parts in the shrimp, for instance, which has scarcely any rostrum at all.

Selection was made of the female prawn as being larger than the male, and therefore more convenient for the purposes of measurement. The largest measured 111 mm. in total body length, the smallest 61·5 mm.

All the measurements having been reduced, as above stated, to fractions of the total body length, they were next arranged in order of magnitude for each organ separately, and in almost every case the values were found to range themselves with a fair degree of symmetry around the median value, and to correspond with more or less accuracy to calculated probability curves. In one case, however (measurement No. VII), the curve presented features of asymmetry which have been investigated by Professor Karl Pearson ('Roy. Soc. Proc.,' vol. 54, p. 329).

The next step was to determine the degree of correlation between various pairs of the organs measured. The method used was that originally suggested by Mr. Galton, and sufficiently explained by Professor Weldon in his paper above referred to, so that it is unnecessary to repeat it here.

The following table gives the value of "Galton's function" for 56 pairs of organs :—

Values of Galton's Function (r) for Pairs of Organs in the Common Prawn.

(The Roman numerals refer to the list of organs measured given above.)

Pairs of organs.	Value of r.	Pairs of organs.	Value of r.
II and IV	−0·30	X and XI	0·61
II " V	−0·34	X " XII	0·58
II " VI	—	X " XIII	0·55
II " VII	0·20	X " XIV	0·55
II " VIII	0·59	X " XV	0·55
II " IX*a*	0·30	X " XVI	0·51
II " X	0·54	X " XVII	0·28
II " XII	0·45	XII " XIII	0·70
II " XIII	0·54	XII " XIV	0·56
II " XIV	0·46	XII " XV	0·56
II " XV	0·54	XII " XVI	0·47
II " XVI	0·59	XII " XVII	0·26
II " XVII	0·40	XIII " XIV	0·71
II " XVIII*a*	0·46	XIII " XV	0·61
IV " VIII	−0·18	XIII " XVI	0·60
V " VIII	−0·40	XIII " XVII	0·28
VI " VIII	−0·16	XIV " XV	0·62
VII " VIII	−0·08	XIV " XVI	0·54
VIII " IX*a*	0·27	XIV " XVII	0·26
VIII " X	0·37	XV " XVI	0·57
VIII " XII	0·37	XV " XVII	0·29
VIII " XIII	0·34	XVI " XVII	0·51
VIII " XIV	0·26	XVI " XVIII*a*	0·43
VIII " XV	0·32	XVI " XVIII*b*	0·49
VIII " XVI	0·39	XVII " XVIII*a*	0·68
VIII " XVII	0·31	XVII " XIX*a*	0·15
VIII " XVIII*a*	0·33	XVIII*a* " XVIII*b*	0·86
IX*a* " IX*b*	0·94	XIX*a* " XIX*b*	0·76

An examination of these values shows that, as might be expected, the highest degree of correlation exists between the paired organs, viz., between the right and left squames, 0·94; between the right and left exopodites of the 6th pair of swimmerets, which, with the telson, form the propelling organ of the prawn, 0·86; between the distances of the spines on the telson from its posterior end, 0·76.

Next, we observe that a strong correlation obtains between the terga of adjacent abdominal segments; their values range between 0·58 and 0·71; while those of segments that do not lie next each other range between 0·47 and 0·61. A considerable fall occurs in the degree of correlation between the telson and the segments of the abdomen—it varies from 0·26 to 0·29, except in the case of the 6th abdominal segment, which lies next to the telson, when the value rises to 0·51. It is interesting to note that Professor Weldon found the corresponding value for the telson and 6th abdominal tergum in the

common shrimp from Plymouth to be only 0·11. Perhaps this difference may in part be accounted for by the fact that the prawn is essentially a swimmer, while the shrimp, in confinement at any rate, spends most of its time standing or crawling on the surface of the sea-bottom. The prawn is certainly a more powerful and rapid swimmer. It swims backwards, propelling itself by means of the hinder part of the abdomen, the terminal portion of which is fan-shaped, the fan consisting of the telson and the exopodites of the last pair of appendages. This hinder half of the abdomen starts from the extended position, and is brought, with a rapid stroke, up under the fore part of the abdomen and thorax, pushing the water before it, and so propelling the animal backwards. The 3rd segment acts as the hinge of the propeller, and it may be assumed that the exoskeleton is here exposed to the greatest strain, for here we find the highest degree of correlation, as is shown by the following figures :—

Index of correlation between terga of abdominal segments	1 and 2	= 0·58.
,, ,, ,,	2 ,, 3	= 0·70.
,, ,, ,,	3 ,, 4	= 0·71.
,, ,, ,,	4 ,, 5	= 0·62.
,, ,, ,,	5 ,, 6	= 0·57.
,, ,, ,,	6 and telson	= 0·51.

Professor Weldon determined three other values in the shrimp, viz., the relations between carapace length and post-spinous portion of carapace, between carapace length and tergum of abdomen vi., and between carapace length and telson. Their values were (in Plymouth specimens) 0·81, 0·09, and 0·18 respectively. It is not possible to institute a comparison with exactly the same organs in the prawn, as, owing to the great variation in the length of the rostrum, no appreciable degree of correlation exists between the whole carapace including rostrum (measurement No. III) and the other organs. But if we take measurement No. II (from orbit to hinder edge of carapace) as an approximate equivalent to the carapace measurements of the shrimp, we find in the prawn the corresponding values are 0·59, 0·59, and 0·40. The difference in the first measurement, viz., shrimp, 0·81; prawn, 0·59, may be accounted for by the fact that the dorsal spines probably do not correspond in nature or function in the two animals. The shrimp has but one median dorsal spine, situated far forward; the prawn has a row of them.

But why the prawn should exhibit a so much higher degree of correlation between the carapace and the two terminal segments of its body than the shrimp is not, I think, readily to be ex-

plained at first sight, unless it be due to difference in habits of locomotion above referred to.

The subjoined table furnishes the necessary data for constructing approximately the curve of each of the separate organs.

The Roman numerals in the first column refer to the organ described above under the corresponding numbers on p. 235; the second column contains the number of animals out of the whole sample of 1000 in which a measurement of the particular organ was made; the third column contains the median value; and the fourth the "probable error" or quartile deviation from the median of each organ expressed in thousandths of the body length; the fifth and sixth columns refer to the same animals after subtracting from their number thirteen individuals in which the rostrum or telson was deformed, and for these the arithmetical mean and probable error (obtained by finding the mean error and multiplying it by 0·845) are given.

All the figures in columns 3 to 6, inclusive, represent thousandths of the body length, except those standing against organ No. I (the body length itself), which represent millimetres.

No. of organ.	Sample of 1000.			Ditto less 13 deformed.	
	No. of animals measured.	Median.	Q_m.	Arith. mean.	Probable error.
I	1000	88·03	4·85	88·20	4·91
II	1000	200·40	3·46	200·43	3·49
III	1000	462·20	7·19	462·56	7·26
IV	1000	130·31	9·83	129·84	10·46
V	998	306·88	8·18	306·95	8·12
VI	998	179·39	8·16	180·39	9·02
VII	998	42·94	2·39	43·11	2·34
VIII	997	155·01	3·66	155·02	3·78
IX*a*	976	159·70	3·29	160·04	3·28
IX*b*	967	160·98	3·26	160·58	3·24
X	863	83·98	1·79	83·91	1·77
XI	999	42·37	1·19	42·21	1·17
XII	1000	101·49	2·08	101·40	2·12
XIII	1000	134·72	2·52	134·69	2·55
XIV	999	114·14	2·37	113·97	2·33
XV	997	77·32	1·61	77·22	1·63
XVI	992	112·39	2·19	112·30	2·26
XVII	998	134·82	2·65	134·83	2·61
XVIII*a*	971	120·84	2·25	120·88	2·21
XVIII*b*	719	120·73	2·36	120·70	2·31
XIX*a*	571	33·33	2·55	33·33	2·73
XIX*b*	572	33·25	2·46	33·27	2·59

In conclusion, I desire to express my warm thanks to Professor Weldon for constant advice and assistance on many points connected with the preparation of the foregoing data.

Presents, March 1, 1894.

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